THE AUSTRALIAN
JOURNAL OF PHYSIOTHERAPY

VOLUME XX MARCH, 1974 NUMBER 1

IDENTIFICATION AND DEVELOPMENTAL ASSESSMENT OF CHILDREN WITH NEUROLOGICAL IMPAIRMENT [1]

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During foetal life, at birth and in the first few post-natal months, the brain is particularly vulnerable to damage. It is at this time that there is rapid development of the central nervous system, a merging of early primitive responses with more complex and later, highly integrated and adaptive responses, and the development of purposeful physical activities.

As infant responses are largely reflex or automatic postural and motor responses, uncomplicated by higher cortical control and compensation, the identification and assessment of basic developmental problems can often be more easily defined at this, than at a later, stage.

In the past, more attention has been paid to the aetiology of the condition than to the study of the quality of behaviour and responses. The main emphasis was placed on achievement of milestones rather than the basis on which they are built. Although defined diagnosis of developmental delay and dysfunction is often difficult, it is well recognised that there is a close link between neonatal and infant neurological developmental dysfunction and later learning problems, and it is also recognised that early treatment and management programmes alleviate some aspects of the problem.

It is therefore important to recognise the sequential development of reactions to particular environmental attitudes and stimuli and to have a constructive and objective way of analysing these reactions and responses.

The goal of early identification is to discover children with neurological impairment, including perceptual motor dysfunction, before they experience disabling frustration as a result of their inability to cope with the normal environmental experiences. The emotional and learning problems found in these children have been and continue to be of great concern to those working in the field.

In an earlier article, "Developmental Perceptual Motor Dysfunction" (Burns and Watter, 1971), the authors reviewed literature available at the time, and described signs which supported a diagnosis of perceptual motor dysfunction. We presented a preliminary chart, which it was hoped would be useful in the testing situation, and described the various areas of dysfunction with a view to introducing a method of treating children with these problems.

Expanding the ideas from the original article and continuing these to their logical and original conclusions has produced several results. Firstly, we feel most definitely that early signs of perceptual motor dysfunction are observable in children under two years of age (Burns, 1973), and that early treatment of the child's problems leads to better results than treatment at a later age. Secondly, from the original "test chart" we have developed a method of approach to assessment which can be used with very young children. Since it relies mainly on observation, we found it of greatest use to assess tasks or behaviours which had already been normalised by researchers in other fields as occurring within a certain age range in the general population. The method can thus be adapted for use in any age group by raising the level of the tasks, and the versatility of the method also permits its use in the assessing of physically or mentally handicapped children. The scheme is based in its entirety on a neurological developmental method, and is a background to the more symptomatic assessment — not a substitute.

Over the past two years, several theorists and research workers have brought to light new functional models and theories which allow a more comprehensive approach to the understanding of the mechanisms of the disorder, and which consequently give an improved basis for the treatment of children with such problems.

NEW TRENDS IN LITERATURE AND THEORETICAL BASES

Attention has been drawn to the interaction and interdependence of the information from various modalities. Thus, if one considers the child under two years, where development proceeds at a rapid rate, perceptual dysfunction in one area will have observable manifestations in many areas of behaviour. At this early age the problems are more readily observable in their basic form than they are two to three years later. By the age of four or five years, the child has learned many compensatory techniques and "splinter skills", which in themselves inhibit the development of adequate sensory processing which is required for normal learning.

Recent work by neurologists theoretically supports the processes of interaction and interdependence of information from sensory modalities (Trevarthen, Gibson, Helg, Bogan). Their work lends

[1] Delivered at the XIII Biennial Congress of the Australian Physiotherapy Association, Brisbane, August, 1973.

support to the theory that integration of sensory input at the brainstem level is essential for the integrity of higher cortical function. Furthermore, it has been shown experimentally that a certain minimal amount of tactile stimulation is essential to maintain the organisation of the brain.

The tactile system is a very diffuse system, and is important in the young as it is the most mature system at birth. It is estimated that three-fifths of all neurones carry tactile information to the brain, and a large portion of these terminate at the brainstem level where they affect neural organisation *via* the reticular activating system.

Such recent work by the neurologists has great significance for our work with very young children. Since tactile and vestibular stimuli provide the young child with much of his early information about his body and his environment, it is of tremendous importance to the child's development if an abnormality exists in this area. As other sensory systems mature, they become more aptly suited to cope with the environment than the tactile system. Correlation of information from all sensory systems is essential for the development of integrative perceptual motor function. Consequently a defect in the earliest sensory information processes has the ability to affect all later developing systems. This in part explains the rationale of Dr. Jean Ayres' work into what she calls Sensory Integrative Dysfunction.

Dr. Ayres hypothesises that "Intersensory integration is dependent on adequate communication between different parts of the brain, including communication between the two cerebral hemispheres. Perception, intersensory integration and interhemispheral integration are basic to learning. . . . The concepts of association of sensory stimuli through convergence of their input on a single neurone, as well as on individual nuclei in both the brainstem and at higher levels of the brain, holds considerable significance for therapy. The process of convergence offers a means by which one type of sensory input stimuli can be employed to influence the perception of input from other sensory modalities." Also, Dr. Ayres states, "One of the main effects is through the vestibular system. . . . This is believed to have influenced auditory processes", and it is postulated "that a similar influence through vestibular and somatosensory stimuli can be exerted on the development of visual perception". "It seems likely then, that the visual, oculomotor, proprioceptive and simple postural and locomotor responses, mediated largely through the brainstem, tend to function together." (Ayres, 1972.)

A significant contribution to the understanding of and early identification of children with potential learning disabilities, has been made by the staff of Meeting Street School, Providence, Rhode Island. For many years children experiencing school failure were referred to them because of a suspected neurological basis for this failure. As the staff believed that inefficiencies in information processing skills were the key to defining a significant number of these children, a composite information-processing model of skill and behavioural factors was worked out. From this model, identification techniques (Meeting Street School Screening Test) and management programmes were developed.

"'Model description' information flows through the processes of orientation, intake, integration, output and feedback. This flow may occur within or between the three major modalities through which children are educated — the visual-perceptual-motor, the language, and body awareness and control (kinaesthetic-gross motor). Characteristically, children with learning disabilities break down in one or more of these five processes, within or across one or more of these three modalities, or break down in behavioural organisation such that they do not orient, integrate or feedback properly during learning processes" (Hainsworth and Siqueland 1969).

The Screening Test is designed for kindergarten and first-grade children and consists of two primary parts — one is primarily medical and the other primarily educational.

A 36-item test which can be carried out by a physician during a routine review of 6-7½ year-olds is designed to reduce the subjective type descriptions of "soft" neurological signs to a more objective test of balance, co-ordination, gross and fine motor performance.

At Meeting Street, emphasis is also placed on identification in the neonatal period as well as during the developmental process of the infant.

RATIONALE OF APPROACH TO ASSESSMENT AND THE SEQUENCING OF TASKS

During the assesment and treatment of babies and children with delayed or abnormal development, it is often apparent that the child has problems associated with the awareness of his body, its position, and awareness of the space through which his body moves. This can cause a lack of planned movement and often causes a fear of movement, and the child is generally unable to learn from experiences encountered, thus finding difficulty in coping with the changing environment. In order to analyse these problems we have endeavoured to group some basic reactions to certain situations. These are not tests, but merely clinical observations. On the basis of our experience, the grouping of the areas of problems appears to be:

1. Awareness of body parts.
2. Awareness of body position.
3. Awareness of position in space.
4. Ability to plan appropriate movement.
5. Ability to learn skills.

1. The development of the awareness of body parts in the baby appears to be dependent largely on tactile information. At first, stimulation produces total reactions towards or against the stimulus, and is associated with survival. Avoidance reactions to certain stimuli — particularly tactile — interfere with learning and cause a negative emotional response. The child may thus become defensive to tactile stimulation.

Normally the development of improved discrimination and localisation enables the child to establish the location of a stimulus and allow him to react in order to cope with that stimulus. This level of behaviour requires the child to have a functional model of his body, its parts and its limits. This occurs as the child moves and is stimulated by touching objects in his environment which gradually produce an awareness of "Me" (*i.e.* the child) and "Not Me" (*i.e.* everything else), developing discrimination and localisation.

2. The awareness of body position relies upon the awareness of body parts and the awareness of the changing relationships that can exist between those parts. Sensory input must also come from kinaesthetic and proprioceptive systems in response to movement, postural change or deep pressure as in supporting. The underlying role of tactile and vestibular stimulation must not be overlooked.

3. The awareness of body space is built up through correlation of information from several areas of input. One of the baby's first spatial reactions is the adjustment of his head to gravity. Concurrently he is reaching out, touching his body and the immediate surrounds in the cones of movement of upper and lower limbs. He consequently develops an appreciation of the limits of his body (a prerequisite for adequate body concept). As he is reaching, he correlates this with visual information on the distance from the object. By visually extending this to objects out of reach he acquires the concepts of subjective space, that is, distance and position of objects relative to his own body. As skills improve, he becomes able to judge the relationships between objects without reference to his own position (concept of objective space).

The interplay of the visual processes of eye follow, convergence and fixation are essential for accurate visual perception and involves space, depth, and postural holding respectively. Normal nystagmus which follows rapid rotational body movement is important for normal postural and balance mechanisms as well as for following a rapidly moving object.

The concept of space is also involved in the recognition of the persistence of matter, that is, recognising an object despite a change in its position, lighting or occlusion from vision. Problems in this area often are manifested as unreasonable fears, or complete lack of fear in dangerous situations. This is the child who cannot rely on his own judgment of spatial relationships, or on the constancy of matter.

Over-reliance on a particular sense. If there is a specific sensory deficit, there may be an over-reliance on some other sensory input. This may be a form of compensation or an attempt to cope with inadequate or confusing information. This type of compensation can be more confusing if the sensory input on which they are relying is incorrect.

4. Movement. Motor planning is the ability to plan economic movement appropriate to the situation. In order to do this, it is essential to have an accurate awareness of body parts, position and an awareness at least, of subjective space. Ontogenetically, motor planning is largely dependent upon neocortical processes (Ayres 1972).

Motor apraxia is the inability to perform a movement even though its nature is understood, and the physical ability to perform the movement is present. Thus apraxia is the functional expression of integrative confusion. It is essential to test the non-habitual tasks, as many situational tasks become learned "splinter skills". The apraxic child is not troubled by involuntary motion, but does not know how to give his body precise directions. Writing and manipulative puzzles involve the highest levels of perceptual development, that is, the greatest skill in motor planning.

It is often in the area of motor planning that the presence of perceptual-motor dysfunction is first noticed because, to be able to motor plan, a child must first be able to function adequately in all the previously described areas. In addition, a high level of cortical integration is necessary. The high level processes involved are described as:

(a) The selection of appropriate information. One of the best examples is seen in the process of visual selection, where the child must scan the visual field and choose the stimulus requiring attention.

(b) The organisation of this information relies essentially on adequate postural stability, which provides a basis for the organisation of other information. There is confusion in the neurophysiological field as to the existence and importance of hemispherical dominance (Touwen 1972). However, we have found that children with unestablished or confused dominance often have problems in other areas when tested. The inability to cross-the-midline is another problem which appears to be related to a lack of dominance. The intrinsic knowledge that the body has two sides, namely laterality, is basic for the development of dominance. This knowledge is built through the ability to discriminate between information from the two sides and the integration of this information.

(c) The persistence or constancy of matter is defined in the discussion of spatial concepts (paragraph 3). For a child with these problems, the information provided by his environment cannot be relied upon. This inconsistent information causes inadequate adaptation, and this in turn often causes apparently illogical fears.

(d) The memory of previous experience plays a large role in the final selection of the child's response. Failure to achieve, and consequent frustration, therefore tend to be perpetuated unless the problem is attacked at its basis. This is most effectively accomplished before inadequate compensatory mechanisms are established, that is, at an early stage of the developmental process (1-36 months).

5. The ability to learn skills. Motor skills involve rhythm, timing, spacing, accuracy, speed and coordination, and are the result of total and efficient brain function. Once a skill is learnt, it may be performed at a subconscious level, but at any time can be consciously organised. These skills are not performed at the same level as the automatic postural responses, and cannot replace them although the former are often used to compensate for the lack of the latter.

There are differing opinions as to the significance of persisting associated reactions. As these are not normally integrated till 6-12 years, testing of these reactions has little overall significance.

METHOD OF ASSESSMENT

In any assessment of a child referred with suspected perceptual motor problems, it is essential to obtain a complete neurological profile to ascertain the developmental maturation level. It is important to record the behavioural state of the child and infant during the assessment, as it will influence certain reaction levels. There are five states recognised in the newborn and very young infant: deep regular sleep, irregular sleep, quiet awake, active awake and distressed (tone is at its lowest during irregular sleep, and high during deep sleep). (Lenard, Prechtl and Bernuth 1968.)

1. Gross Motor Ability. This involves the spontaneous and functional activities of the child, the amount, intensity, and the purpose of the activity. Note any asymmetry.

2. Significant Neurological Signs. These imply C.N.S. damage and may be noted as such.

Level of Reactivity (hyper; hypo)	Tremor
Tendon Reflexes	Involuntary movement
Basic muscle tone (hyper; hypo) (fluct; rigid)	Babinski
	Opisthotonus
	Associated reactions
Clonus	Synkinesis

3. Abnormal Reflex Patterns. The absence of these in the newborn or the perpetuation of these patterns beyond the normal age for integration is a significant indication of delayed development. These reflexes may persist in a very subtle form, especially in the older child, and are one of the significant mild signs of Minimal Cerebral Dysfunction.

Moro	Tonic labyrinthine (supine; prone)
Galent	
Withdrawal	Asymmetrical Tonic Neck Reflex
Tonic Grasp (hand; foot)	Symmetrical Tonic Neck Reflex
Rooting	
Sucking	Stepping Reaction
Bite	Extensor Thrust

4. Postural and Balance Reactions. The development of postural reactions not only integrates the primitive reflex reactions, but is highly significant for the development of an adequate body schema, which is the basis for all efficient movement. The absence of any of these reactions seems to contribute to perceptual-motor problems and is significant in children with learning problems.

Placing (feet; hands)	(right side and left side support prone and supine)
Landau	
Righting Reactions	Protective Reactions of arms (forward; sides; back)
Head on body;	
Body on body;	legs ("parachute")
Body on head;	Equilibrium Reactions
Head to gravity with vision;	(lying; sitting; standing)

5. Reactions and Function Relative to Position. This indicates the child's ability to cope with the environment and is affected by reflex activity, postural adjustments (see 3 and 4) and sensory integration.

Supine	Kneeling
Prone	Standing
Rolling	Walking
Sitting	
Crawling	Hands

6. Vision (Burns and Watter, 1971). Visual information makes important contributions to the development of body position awareness, body space, and movement, as discussed. Disturbance in the visual fields, eye co-ordination (binocular) and fixation must therefore be tested.

Nystagmus	Eye follow (horizontal vertical diagonal)
Strabismus (convergent; divergent)	(N.B. particularly note eyes as midline crossed)
Binocular vision	
Eye contact (fixation)	Eye-hand accuracy

Note that in sections 7 to 10, age levels have been quoted as guidelines for the assessment of developmental levels not as specific tests. The age levels have been drawn from normative studies by Gesell & Armatruda, Griffiths, Illingworth, Bobath and Piaget.

7. Awareness of Body Parts.

(i) Observe automatic motor activity of the child and note any asymetry or disregard of a limb or limbs.

(ii) Observe visual attention to, or withdrawal from, a part touched. If there is no response, test reaction to a painful stimulus.

(iii) Check level of body awareness —

1 month — push foot against parent's hand.

2½ months — moves arms, kicks both legs.

3 months — plays with fingers.

5 months — ring to mouth.

8 months — transfers object hand to hand.

12 months — claps hands.

14 months — usually can show toes and arm.

22-24 months — show all parts of body on request.

By 3 years — name body parts indicated.

(iv) Astereognosis. This is the inability to distinguish between the shapes of common objects placed in the hand with the vision occluded. This test is suitable only for the over-3-year-olds. Make sure the child can identify the objects visually first, but older children should be able to identify directly.

(v) Tactile Finger Agnosia. Inability to identify fingers touched while vision occluded (5 years). The dropping of an object from the hand once the visual contact is lost could be indicative of agnosia in the infant over 9 months and the young child.

(vi) Avoidance Reactions (Tactile Defensiveness). Avoidance Reactions indicate: (i) Primitive level of response to stimulation; or (ii) Rejection of a particular sensory input. They can be:

(a) Tactile — (Normally at birth there is no hand avoidance but rather a grasp reaction or reflex)

(b) Visual — (Normally by 1 month the eyes turn to a light. By 3 months there is eye follow horizontally and vertically. By 4-5 months child reaches and grasps a ring)

(c) Auditory — (In the 1st month, reaction to sound is "startle reaction". In the 2nd month there is cessation of movement. By 4 months there is localisation of sound by turning eyes and head to the source).

8. Body Position Awareness.

(i) Test postural reactions at the appropriate developmental level.

At birth — Moro.

2-3 months — Head "Righting" appears, test in suspension with limited tactile input.

4-6 months — Body "Righting" appears (segmental rolling).

6-7 months — Landau reaction (pre-requisite for normal standing).

6-7 months — Protective extension of arms — forward.

8 months — Protective extension of arms — sideways.

8 months — "Parachute" reaction (protective reaction of legs).

10 months — Protective extension to the back, or may be superseded by the development of "Equilibrium" reactions, in sitting.

(ii) In children over 2 years, check the ability to hold a static posture (postural holding or co-contraction).

(a) Ability to sit still (i.e. without postural sway).

(b) Ability to stand still (about 2 years).

(c) To hold arms still and hands extended in front of body (about 5 years).

(d) As above (c) but turn head to right and left without change in arm position. Test with eyes open and closed (6 years +).

(e) Note or test basic postural tone for
(i) hypotonia;
(ii) rigidity.

(iii) Awareness of limb position. (Position Agnosia)

4 months — early reach and grasp.

5 months — toy to mouth.

6 months — plays with toes.

10 months — crawling into and out of unusual positions.

14 months — can show arm for coat, foot for shoe.

18 months — will copy an easy position (bridge for car).

24 months — can kick a ball.

5 years + — can name limb position without vision.

Observe automatic corrections of posture for comfort without needing extra visual or tactile information, such as repeated fingering, touching or tapping (*e.g.* freeing a caught limb).

(iv) Check synkinesis. Normally strongest at 2 years, integrated by 5 years.

9. Awareness of Body Space. The vestibular reactions are important for the accurate development of spatial concepts. Therefore the head righting reactions tested in 4 and 8 have important implications here and should be tested with the vision occluded and tactile input limited. Test in all four positions.

Visual fields: The contribution of vision in the spatial orientation of the child is enormous and it is therefore essential to know if the child is receiving information from all areas of the visual fields. Once the child is old enough, full visual field testing is recommended, but in the young child and infant observe the following:

Binocular eye follow in both planes and directions; *i.e.* horizontal, vertical, diagonal. The focussing of eyes on an object and convergence. (Refer test 6.)

(i) Note if any part of the visual field is ignored and particularly note head posture.

1 month — eyes will watch a moving light.

2 months — follow in horizontal plane.

2½ months — follow in vertical plane.

3 months — follow circular movement and will fixate on a point.

3-4 months — eyes converge accurately on an object.

Nystagmus — Rapidly rotate the child and note the eye movements. Note eye movements while child watches a moving object.

Note abnormal fixation or lack of co-ordination.

(ii) Spatial development.

6 months — reaches for toy (distance and depth judgment).

7 months — looks for fallen toy (persistence of matter).

8 months — passes object from hand to hand (concept of subjective space).

9 months — crawls under chair to retrieve object (whole body space awareness beginning).

9 months — lifts cup to find a toy which he saw being hidden (persistence of matter).

12 months — begins furniture walking and manipulates the body through space.

12-15 months — equilibrium reactions developed first in sitting, then standing.

15 months — climbs up a step.

16 months — lifts a cup seeking a hidden toy.

18 months — builds a block tower.

2 years — drives cars through spaces, crashes, and near misses (concept of speed, time, depth and distance).

2 years — jumps off a step.

3 years — can judge relative size between objects (objective space developing).

(iii) Fears: Note exaggerated fears of heights, noises or other environmental changes. Note absence of fear in dangerous situations, e.g. stepping into space from a height.

(iv) Over-reliance on a particular sense. Is the child—

(a) Tapping hands, legs or moving body parts all the time (to increase proprioceptive or tactile information).

(b) Relating to a particular visual line (constant stimulus) such as a railing or pattern on the floor. If this is interrupted, the child may be seen to lose balance or even fall.

(c) Similar to (b) but requiring auditory continuity.

(d) Compensating by cognitive processes such as constant verbalisation of his sensory input.

10. Motor Planning. The ability to plan and carry out economic movement, appropriate to the situation, as already discussed, requires integration of basic information but also the selection and organisation of all information available to the child. As mentioned, unestablished or confused dominance is often to be found in association with other problems. Therefore it is significant to record the level of maturation of this feature.

(i) Check level of dominance and awareness that the body has two sides.

3-4 months — localises tactile stimuli; an asymmetrical stage.

4 months — localises sound.

4 months — holds cube in either hand but when offered another, drops the first.

6 months — unidextrous approach.

7 months — transfers cube from hand to hand; sometimes may use bi-dextrous approach.

8 months — holds cube in one hand while manipulating with the other hand.

10 months — bangs two cubes together.

13 months — preference for one hand begins to develop but more marked by 18 months.

18-24 months — at this stage associated movements are aften strong, *i.e.* during the use of one limb.

3½-5 years — formal tests of dominance are significant.

For valid results, tests must be made over an extended number of trials —

Pick up a centrally placed pencil for drawing (hand).

Pick up a centrally placed cone to look through (eye).

Kick a centrally placed ball as in a "mark" (foot).

Hop on one foot.

(ii) Check the ability to cross-the-midline.

2 months — eye follow across the midline — horizontal plane.

2½ months — vertical eye follow.

3-4 months — circular eye follow.

It is important to note smoothness of movement. Jerkiness as the eye follow crosses the midline is significant.

4 months — hits at an object across the body if encouraged.

6 months — unilateral stage but brings both hands to midline.

8 months — passes toy from hand to hand.

10 months — in sitting, twists around to either side to reach toy.

15 months — plays cars in and out of legs and around the body.

20 months — vigorous straight scribble across the midline.

24 months — scribble horizontal strokes. Helps to dress and undress frequently, which involves crossing right to left and left to right.

Kephart tests (as per ref. 1966).

1. Draw a large circle on the blackboard.
2. Draw two circles at once, one with each hand.
3. Joining two widely space dots
   (a) horizontally;
   (b) vertically.

(iii) Gross Motor Apraxia can be tested by tasks set at the appropriate age level.

3-4 months — removes cloth covering face.

6-7 months — secures a dangling ring, repeatedly moves a toy in order to produce a noise.

8 months — strikes one object with another.

8-9 months — pulls a string to secure toy attached.

9-11 months — organises body through space, *e.g.* sitting to lying, crawl to sitting.

12 months — furniture walks.

13 months — climbs onto small step or ledge.

14 months — about this time, independent walking.

15 months — climbs up stairs, pushes toys along.

By 18 months — can get on and off a chair. Constructive play with boxes and other material.

At this time will attempt to organise toys and body to achieve an end, and even if inefficient, will persevere. An apraxic child will give up his vain attempt and ask for the task to be completed by another.

(iv) Ability to organise the body into a demonstrated position (minimal verbal clues). For accurate testing it is essential to test non-habitual tasks. Waving "ta-ta", clapping hands, removing shoes and socks and crawling are "habitual" tasks and can be learned skills.

10 months — clicks 2 bricks together in imitation; will copy hand banging or rolling.

12 months — removes an object from a box when shown.

15-18 months — copy simple movements as games, *e.g.* placing a car.

By 24 months — ask "copy a bridge", "sit like me".

3 years — copy symmetrical limb positions, arms elevated or abducted.

4 years — copy arm and leg positions in three planes (all movements are more precise and accurate). Copy patterns of movement involving change of direction.

N.B. It is not the achievement of the task in the area of motor planning that is important, but rather it is the selection, organisation and quality of performance of these tasks which should be considered.

(v) Ability to organise the body in response to verbal instruction only. Difficulties here will be apparent in the whole test situation.

After the age of three years, however, more detailed testing involving fine motor abilities are important.

15 months — follows simple commands, *e.g.* put the car in the box.

18 months — go and sit on the chair, which involves spatial concepts.

24 months — can remember to do two simple tasks "put the ball on the box and bring your shoes over here". Also can put body in different positions, and hide various parts of the body. Will imitate familiar tasks, "sweep the floor like mummy".

(vi) Fine motor apraxia. The main body parts requiring fine control are the oral-musculature for speech and the hands for directed manipulation.

(a) Articulatory Dyspraxia (Apraxia) is a defect of articulation resulting from C.N.S. damage where the speech muscles and movements appear normal, but lack adequate control and direction to reproduce sequences of sounds used in speech.

(b) Manipulatory Apraxia. Likewise, the nature of the task is understood and the necessary movement possible but there is an inability voluntarily to direct and co-ordinate the desired appropriate movement. The child with problems has trouble with constructive manipulatory play and may resort to destruction of the objects. The apraxic child usually learns to do the normal functional activities but at a slower rate. However the achievement of these tasks will not diminish his apraxia, which will be readily observed in unfamiliar situations.

18 months - 3 years — constructive play with blocks, construction toys, and small manipulative tasks such as threading.

Pre-school — scribbling, painting, cutting, pasting, drawing and assembling.

School — writing, puzzles, pattern building and also dressing and undressing.

(vii) Ability to learn skills. Observe rhythm, timing, spacing, speed, direction and co-ordination in the following activities:

bouncing a ball, patting a ball, hitting or catching a suspended swinging ball;

jumping a moving rope, performing "jumping jacks";

trampolining and skipping;

alternating hand tapping;

copying "tap" patterns (involve auditory discrimination and memory);

diadachokinesia — alternating forearm movements;

following a designated path;

rapidly changing from one activity or direction to another.

VALUE OF ASSESSMENT

Longitudinal studies carried out in Providence, Rhode Island, over a seven-year period admirably summarise our contentions.

"Conclusions:

1. As much attention ought to be paid to careful descriptions of behaviour and function in the new-born period as to the search for aetiology.

2. Carefully weighted paediatric observations correlate significantly with psychoneurological function seven years later.
3. Composite indices (of neurological outcome in particular) are better indicators of the at-risk infant and his later development than single measures of either stress or outcome.
4. Early tagging of stressed or neurologically suspect children could have great value in pointing to the need for a programme of developmental stimulation possibly to reduce the incidence of inadequate function and achievement at school age." (Denhoff, Hainsworth, Hainsworth, 1971.)

Most assessments of infants suspected of having neurological impairment are unreliable indicators of the final degree of handicap. The inclusion of perceptual-motor testing on a developmental basis makes the assessment a more significant prognostic indicator. However, throughout this assessment, only a basic idea of adequacy is obtained in areas of audition, conceptual space and fine manipulative skills. More detailed assessment would be beneficial.

From a full assessment as described, areas of deficit become more clearly defined and thus treatment can become more specific.

During treatment, particular techniques have been found which stimulate or facilitate the reactions required. When this is not possible treatment is aimed at helping the child compensate more adequately for the loss.

CASE HISTORIES

RODNEY. Born 28.11.1966.

First assessed in June, 1972.

Perinatal History: None — adopted child.

Developmental History: Walked at 14 months, was late learning to feed himself and was unable to dress himself at all. A few weeks after starting school he developed emotional disturbances associated with severe problems in copying, doing jigsaws and puzzles, *etc.*

Assessment:

1. Gross Motor Ability. Good. He could run, jump and hop; however much of his activity was not completed and was purposeless (hyperactive).

2. Abnormal Neurological Signs included tremor and inco-ordination of hand movement. Mild nystagmus and corrected strabismus. Hyperactive.

3. No abnormal reflexes present.

4. Postural and Balance reactions: Rodney used protective extension of arms and legs in preference to equilibrium reactions which were present but delayed. Mixed righting reactions were present.

5. Reactions and function relative to position — good generally, but gait was heavy and primitive.

6. Vision. Nystagmus and corrected strabismus present. Tends to use eyes alternately, not binocularly. Poor eye follow, fixation and poor eye-hand co-ordination.

7. Awareness of body parts — could name body parts but confused about localisation of touch. Could not two-point discriminate (hand-face).

8. Body position awareness — poor. Resisted change of body position. Used protective extension, not equilibrium reactions (present but slow). Could not hold a static posture without building up tactile and kinaesthetic/proprioceptive clues. Worse with vision occluded. Mixed poor head-righting responses.

9. Awareness of body space — poor use of visual fields, poor visual abilities ref. 6 above. Spatial concepts fair but over-steps, over-reaches. Could not jump a moving rope on the floor.

Over-reliance — builds up tactile-proprioceptive stimuli by tapping, moving, *etc.*

10. Motor Planning — very poor. Trouble crossing the midline and dominance mixed. Had learned "right and left" but could not be consistent with his body. Could not copy demonstrated positions, but after verbal instructions this improved a little. Showed no gross apraxia but did show fine-skill apraxia. Poor ability to learn skills and learn from any new situation.

Progress:

Rodney has been on treatment since July 1972. He has improved in his attention span and ability to persevere. Postural reactions are more mature (equilibrium used now). Eye-follow, fixation and orientation are mostly improved, so is his ability to use both eyes together. Eye-hand co-ordination is better but still not good. Awareness of body parts has improved inasmuch as he can name and show parts. There is still confusion in localising tactile stimuli. His body position awareness has improved greatly, and he no longer resists position change. He still shows spatial problems but at a higher level. Motor planning has improved markedly. Can copy positions (verbal and demonstrated) and fine apraxia is improved.

SEAN. Born 31.8.1970.

First assessed 6.4.1972.

Perinatal history: Mother a diabetic who went into coma at six months gestation. Was hospitalised until the birth. Sean was hypoglycaemic and born by Caesarian section.

Developmental history: Sean had slow milestones and kept his right hand fisted.

Assessment:

1. Gross Motor Ability. Rolling, sitting, standing and some walking. Right arm not used and poor weight-bearing right leg.

2. Abnormal neurological signs. Generalised mild hypotonia, some hypertonicity right side.

3. Abnormal reflex patterns. Grasp with adducted thumb right hand.

4. Postural and Balance Reactions. Uses protective reactions, not equilibrium in arms and trunk. Slow equilibrium reactions in legs. No head righting. Poor placing of right hand and foot. Balance generally poor in standing.

5. Reactions and function relative to position.

6. Vision within normal limits but poor visual attention to right side.

7. Awareness of body parts. Asymmetry present due to disregard to right side, arm worse than leg. No pain reaction on this side, and poor visual attention to right side. Dislikes handling of right side.

8. Body position awareness. Postural reactions poorly developed. Protective reactions used in arms in preference to equilibrium reactions. No head-righting to gravity. Slow equilibrium reactions in legs. Synkinesis normal for age.

9. Awareness of body space. Disliked climbing and showed fear of heights, where he tried to build up proprioceptive and tactile clues. Sometimes stepped off into space with no fear. N.B. head righting reactions poor.

10. Motor Planning. Poor recognition of right side, and no crossing the midline from the right arm. Right leg would cross. No true gross apraxia seen.

Progress:

Sean has been treated since his assessment. His basic tone is low-normal and his grasp reflex and thumb adduction has gone. He tends to use the more mature equilibrium reactions normally but under stress reverts to protective reactions, especially in arms. Head reactions unaltered except for a tendency to extend (right) in prone suspension. Visual attention has improved to the right side. Responds now to tactile and pain stimuli and has improved tolerance to handling of his right side. Still shows fear at height and tries to build up clues in these situations. Motor planning improving.

PETER. Born 5.11.1967.

First assessed July 1972.

Perinatal History: Normal pregnancy and delivery. At 5½ months had a convulsion associated with fever, and a right Jacksonian onset. Recurrent fits from age three and from January 1972, recurrent grand mal seizures were seen. Right hemiplegia was noted at this time.

Developmental History: At two years, development was delayed. At three years he was felt to display minimal cerebral damage. At five years he had developed severe spastic quardiplegia (right worse than left), with perceptual motor problems following status epilepticus.

Assessment:

1. Gross motor ability — very poor.

2. Significant neurological signs. Inattentive, with hypertonicity (extensors particularly) and clonus. Early movement in left side was very unco-ordinated.

3. Abnormal reflex patterns. Some influence of A.T.N.R. to the right, and tonic labyrinthine reaction still present.

4. Postural and balance reactions. No placing on right side, and he showed delayed righting reactions in sitting (left side better than right). No parachute leg reaction, and no equilibrium reactions seen.

5. Reactions and function relative to position:

Supine — Raised head, brought left hand to midline.

Prone — Pushed up on left arm.

Rolling — Rolled to right side, prone to supine, supine to prone.

Sitting — Long sitting used and was stable due to increased extensor tone in legs.

Crawling — None. He held the prone kneeling position with minimal support.

Standing — Took full weight on both legs without spasm.

Hands — Right — no voluntary active function; Left — good active function but poor co-ordination and poor manipulative skill.

6. Vision. Peter showed a right peripheral field vision defect. Eye contact and fixation poor.

7. Awareness of body parts. Totally disregarded right side, depressed awareness of left side. Withdrew right side from stimulation and became defensive (rejection of input).

8. Awareness of body position. Peter had poor postural reactions and could not change position once he was placed. He had poor awareness of limb position and frequently left limbs in uncomfortable positions.

9. Awareness of body space. Delayed righting reactions seen, and there was a right peripheral visual field defect. Further testing difficult at this stage.

10. Motor planning. Unaware of right side, and was left-handed. Midline crossing poor with left hand and non-existent with right. Position copying non-existent and body organisation poor. Fine motor apraxia present left side (manipulatory).

Progress:

Peter is moving himself from one position to another and is walking around in a walking frame. Attention has improved. He is beginning to "right" in all positions but is tending to over-react now. His A.T.N.R. is shown only under stress and tonic labyrinthine reaction is largely integrated. Peter now has momentary standing balance and can maintain prone kneeling. His awareness of limb position and body parts have improved but still poor, and he is attending to his right visual field. His motor planning, although improved, is still poor.

SUMMARY

Early identification of children with neurological impairment indicates those children who are likely to experience difficulty in coping with their environment.

Treatment can then be implemented before the child experiences disabling frustration, or develops secondary problems. Literature reviews theoretically support the hierarchy of development of sensory systems. This has important implications for the rationale of the assessment plan described in this paper. The assessment which relies on accurate clinical observation (not a standardised test) covers basic neurological areas, and includes detailed perceptual motor assessment. These together provide a versatile method whereby children of all developmental levels can be assessed. Case histories have been cited to show how the assessment can be used to define problem areas.

BIBLIOGRAPHY

AYRES, A. JEAN (1972). *Sensory Integration and Learning Disorders.* Western Psychological Services, Los Angeles.

AYRES, A. JEAN (1972). "Basic Concepts of Occupational Therapy for Children with Perceptual-Motor Dysfunction." *Proceedings of Twelfth World Congress of Rehabilitation International* Vol. 2, page 556.

BOBATH, B. (1968). *Abnormal Postural Reflex Activity Caused by Brain Lesions.* William Heinemann Medical Books, London.

BURNS, Y. and WATTER, P. (1971). "Developmental Perceptual Motor Disorders." *Australian Journal of Physiotherapy*, xvii, 3.

BURNS, Y. R. (1973). "A Developmental Approach to Identification and Treatment of Children with Minimal Cerebral Dysfunction." Seminar Proceedings *Identification and Treatment of Children with Learning Disabilities.* Fred and Eleanor Schonell Educational Research Centre, University of Queensland.

DENHOFF, E., HAINSWORTH, P., HAINSWORTH, M. (1971). "Early Childhood Education, an Information Processing Approach", from Myklebust (1971) *Progress in Learning Disabilities* Vol. II. Grune and Stratton, New York.

FLAVELL, J. H. (1963). *The Developmental Psychology of Jean Piaget.* Princeton, New Jersey, A. Van Nostroud Co.

GESELL, A. (1940). *The First Five Years of Life.* Harper and Brothers, New York and London.

GRIFFITHS, R. (1954). *The Abilities of Babies.* London University Press.

HAINSWORTH, P. and SIQUELAND, M. (1969)."Early Identification of Children with Learning Disabilities." *The Meeting Street School Screening Test.* Meeting Street School, Providence, Rhode Island, Cripple Children and Adults Inc., Rhode Island.

ILLINGWORTH, R. S. (1963). *The Development of the Infant and Young Child, Normal and Abnormal.* E. & S. Livingstone, Edinburgh and London.

KEPHART, N. C. & ROACH, E. G. (1966). *The Purdue Perceptual Motor Survey.* Merrill Books Inc., Columbus, Ohio.

LENARD, BERNUTH, PRECHTL (1968). "Reflexes and Their Relationship to Behavioural State in the Newborn." *Aeto. Paediat. Scand.*, 177-185.

TOUWEN, B. C. L. (1972). "Laterality and Dominance." *Developmental Medicine and Child Neurlogy* 14; 6. Spastics International Medical Publications, London, U.K.